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(54) Title: TRIMODULAR ULTRASONIC DENTAL DEVICE

(57) Abstract

A three–part ultrasonic dental insert and replacement system used in a handpiece having an induction coil disposed about a well and operably connected to power supply. The three parts include a magnetostrictive element, a velocity transducer and a tip. The magnetostrictive element has a crown at one end which is releasably attached to a distal end of the velocity transducer. The tip is releasably attached to a proximal end of the velocity transducer. The insert can comprise a set of interchangeable tips wherein the velocity transducer and the tips are ultrasonically operable with the coil and the magnetostrictive element. The three–part replacement system comprises a set of the magnetostrictive coils and a set of the velocity transducer elements, as well as the interchangeable tips. The velocity transducer and tip sets include a plurality of transducer–tip combinations ultrasonically operable at the ultrasonic frequencies of the magnetostrictive elements.

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TRIMODULAR ULTRASONIC DENTAL DEVICE

FIELD OF THE INVENTION

This invention relates to ultrasonic dental instruments, and more particularly to a three-part ultrasonic dental insert for an ultrasonic handpiece.

BACKGROUND OF THE INVENTION

Ultrasonic dental scalers and surgical instruments are available from several different suppliers. These units generally have a power supply unit and a handpiece connected to the power supply by a cable by which electrical current and water are typically supplied to the handpiece. The handpiece includes a tip insert which has a transducer stack which interacts with an alternating magnetic field created by a coil in a wall of the housing to set up an ultrasonic vibration of the insert. The insert generally has a dental tool or tip which is integral with the transducer stack or removably attached thereto.

In this prior art design, the insert and tip are removable from the handpiece for sterilization in an autoclave. When the tip or transducer stack fail or wear sufficiently to be replaced, this is done by replacing the entire insert in the case of the integral stack and tip insert, or by replacement of the stack or the tip as necessary in the two-part insert system. The transducer stacks and tips, as well as the complete insert, can be expensive to replace, particularly where the insert comprising the transducer stack and tip is a one-piece insert.

Some manufacturers provide a variety of tips which can be used with the same transducer stack and handpiece. This provides versatility in that the ultrasonic dental tool can be used for different purposes or operating conditions. However, one manufacturer's tips are not generally interchangeable with another manufacturer's. This is due, not only to the different connection between the tip and stack which may be employed, but also because of the different operating frequencies which are employed. The nature of ultrasonics requires that the tip be matched with the transducer stack so that the end of the tip corresponds to a node of maximum vibration, whereas the connection of the transducer stack to the handpiece must correspond to an antinode where there is little or no vibration which would otherwise generate heat and ultimately result in a failure of the connection. Since changing the length or the operating frequency will change the location of the nodes, and of the antinodes, the interchangeability of the tips between different manufacturers is problematic.

Applicant has found that it would be desirable to reduce the cost of replacing broken or worn components of an ultrasonic dental insert. Applicant has further found that it would also be desirable to be able to interchangeably use tips and transducer stacks in different handpieces of different manufacturers.

SUMMARY OF THE INVENTION

The present invention is directed to a three-part ultrasonic dental insert used in a handpiece of an ultrasonic dental tool. By providing the dental insert as a three-part unit, the various parts

can be made interchangeable from one insert to another. In addition, the three-part assembly allows the replacement of broken or worn components individually, rather than as a complete unit.

In one aspect, the present invention provides a three-part ultrasonic dental insert for use in a handpiece having an induction coil disposed about a well and operably connected to a power supply. The dental insert comprises a magnetostrictive element, a velocity transducer and a tip. The magnetostrictive element has a crown at one end and the other end is adapted to be received in the well of the handpiece. The magnetostrictive element has a magnetostrictive frequency matching the coil and power supply. The velocity transducer has proximal and distal ends. The distal end is releasably attached to the crown of the magnetostrictive element. The tip has a distal end releasably secured to the proximal end of the velocity transducer. The velocity transducer and the tip are ultrasonically operable with the coil and magnetostrictive element.

As used herein, the term "ultrasonically operable" means that the components are matched for ultrasonic operation at the frequency of the coil/magnetostrictive element, i.e. the proximal end of the tip corresponds to a node and the insert includes an antinode, at or near which the insert can be secured to the handpiece, at the operating frequency of the coil/magnetostrictive element.

In another aspect, the present invention provides a three-part ultrasonic dental insert for use in a handpiece having an

induction coil disposed about a well and operably connected to a power supply. The three-part ultrasonic dental insert comprises a magnetostrictive element, a velocity transducer releasably attached to the magnetostrictive element, and a set of interchangeable tips. Each tip has a distal end releasably attachable to the proximal end of the velocity transducer. The velocity transducer and the tips are ultrasonically operable with the coil, the power supply and the magnetostrictive element.

In yet another aspect, the present invention provides a three-part replacement system for repairing ultrasonic dental inserts for use in handpieces having an induction coil disposed about a well and operably connected to a power supply. The replacement system comprises a set of magnetostrictive elements, a set of velocity transducers and a set of interchangeable tips. The magnetostrictive elements have a crown at one end and are receivable in the well of the handpiece. The set of magnetostrictive elements includes at least two elements having different magnetostrictive frequencies to match coils operable at different frequencies. The velocity transducers have proximal and distal ends. The distal ends of the velocity transducers are releasably attachable to the crowns of the magnetostrictive elements. The tips have distal ends releasably attachable to the proximal ends of the velocity transducers. The velocity transducer and tip sets include a plurality of transducer-tip combinations ultrasonically operable at the ultrasonic frequencies of the magnetostrictive elements. The set of velocity transducers preferably includes at least one velocity transducer matched for

interchangeable operation at different ultrasonic frequencies with at least two different magnetostrictive elements. The interchangeably operable velocity transducers are preferably operable at ultrasonic frequency pairs selected from the group consisting of: about 18 kHz and about 18.8 kHz; about 25 kHz and about 30 kHz; and the like. The set of tips preferably includes a plurality of tips operable with a plurality of velocity transducers for operation at different ultrasonic frequencies.

BRIEF DESCRIPTION THE DRAWINGS

Fig. 1 is a longitudinal section of a stack section of a trimodular ultrasonic dental device according to the present invention.

Fig. 2 is an enlarged longitudinal section of the crown or head piece used in the stack section of Fig. 1.

Fig 3 is a cross section of the stack section of Fig. 1 as seen along lines 3-3.

Fig. 4 is a longitudinal section of a velocity transducer section used in a trimodular ultrasonic dental device according to the present invention.

Fig. 5 is a cross-sectional view of the velocity transducer section of Fig. 4 as seen along the lines 5-5.

Fig. 6 is a longitudinal section of a tip used in a trimodular ultrasonic dental device according to the present invention.

Fig. 7 is a perspective view of an assembled trimodular ultrasonic dental insert in a handpiece.

Fig. 8 is a longitudinal sectional view of a handpiece containing the insert (without the tip).

DETAILED DESCRIPTION OF THE INVENTION

With reference to Figs. 1-8 wherein like numerals are used to indicate like parts, the insert **10** (Fig. 7) includes a magnetostrictive element **12** (Figs. 1-3), a velocity transducer **14** (Figs. 4-5) and a tip **16** (Fig. 6). The magnetostrictive element **12** includes a plurality of magnetostrictive leaves **18** which are stacked together and can be secured at either end thereof as is known in the art. The magnetostictive leaves can be made of any suitable magnetostrictive material, such as, for example, nickel. The leaves **18** are preferably brazed at either end, for example, silver brazed. The proximal end of the stack of magnetostrictive leaves **18** is received in a bore **20** formed in a distal end of a crown or head piece **22**. The magnetostrictive leaves **18** are preferably silver brazed at **23** into the bore **20** of the head piece **22** to secure the magnetostrictive leaves **18** as a stack thereto.

The head piece **22** has a generally cylindrical outer surface and includes the bore **20** formed in the distal end thereof as previously mentioned. The proximal end of the head piece **22** can include tapered threads **24** terminating at a transverse abutment surface **26**, or alternatively straight threads or a friction fit (not shown) could also be employed. The preferred tapered threads **24** are machined with rounded ends, and enhance the metal-to-metal engagement area for the transmission of vibration from the magnetostrictive element **12** to the velocity transducer **14**, as described in more detail below. A transverse bore **28** is formed through the head piece **22** which serves as a water inlet port, and

also to receive a tool for threadedly engaging the magnetostrictive element **12** into the velocity transducer **14**. A longitudinal bore **30** is formed through the head piece **22** extending from the transverse bore **28** and opening to the abutment surface **26**. The bore **30** serves as a passage for water through the head piece **22** into the velocity transducer **14**.

The velocity transducer **14** has a distal end with a tapered, threaded bore **32** and transverse abutment surface **34** for receiving the tapered threads **24** and abutment surface **26** of the head piece **22**. The velocity transducer **14** includes a distal section **36** with an enlarged outside diameter, relative to an outside diameter of proximal section **38**, and preferably the outside diameter of the distal section **36** matches the outside diameter of the head piece **22**. A transverse bore **40** is formed through the distal section **36** to facilitate attachment of a tool for threading the velocity transducer **14** to the head piece **22** of the magnetostrictive element **12**. A central passage **42** through the velocity transducer **14** is provided for water to flow therethrough.

An O-ring **44** is received in O-ring groove **46** formed in an outer surface of the distal section **36** to provide a friction fit of the velocity transducer **14** in the handpiece **10**. The proximal end **38** of the velocity transducer **14** can receive a contoured finger grip **48** which has an interior bore just slightly larger than the outside diameter of the proximal section **38**. The finger grip **48** can be contoured to facilitate tactile engagement, and may be made of any suitable material such as a thermoplastic or thermosetting

polymer. The proximal section **38** of th velocity transducer **14** can include longitudinally spaced-apart O-ring grooves **50** which receive O-rings **52** and provide a seal with the finger grip **48** when received on the proximal section **38**. The finger grip **48** can also be provided with interior ribs **54** corresponding to the grooves **50** to provide a snap-on engagement of the finger grip **48** with the section **38**. The O-ring grooves **46,50** can generally correspond to points of very little vibration, or antinodes, to minimize the generation of heat at these locations. The internal passage **42** terminates at threads **56** (preferably tapered) adjacent the proximal end of the section **38** for engagement of the tip **16**.

The velocity transducer **14** is generally machined from thick-walled tubing of suitable autoclavable material, such as stainless steel, for example.

The tip **16** has a proximal working end **60** and a tapered threaded distal end **62** adapted to be threadably engaged in the passage **42** by the terminal threads **58** (preferably tapered) of the velocity transducer **14**. The tip **16** includes a central passage **64** for water to flow therethrough. The proximal end **60** generally corresponds to a vibration node, i.e. a location at which vibratory motion is at a maximum. The tip **16** is generally manufactured from a tubing piece of the appropriate inside and outside diameters which is bent and molded into the desired shape and then hardened and polished. A stainless steel such as 420 or 440 grade is generally suitable for this purpose, but, depending on the function or purpose of the tip **16**, it can also be made from

titanium or other materials, and can optionally be coated with an abrasive material such as diamond. The tip **16** can be a universal tip, a left tip or a right tip, have flattened sides and a spooned end, or can be a surgical blade, or the like.

In operation, the insert **10** (Figs. 7 and 8) is assembled for use from the desired magnetostrictive element **12**, velocity transducer **14** and tip **16**. The assembled insert **10** is then placed inside a suitable handpiece by frictional engagement, for example, by means of O-ring **44**, and supplied with power to induce vibration of the magnetostrictive element **12**. The magnetostrictive element **12** is vibrated by passing an alternating current supplied via wires **72** through coil **74** formed in the shell of the handpiece **70**. Vibration is transmitted from the magnetostrictive element **12** through the velocity transducer **14** and then to the tip **16**. Water is supplied to the handpiece **70** via tubing **76** and nipple fitting **78** and flows through the well **80** receiving the magnetostrictive element **12** to cool the magnetostrictive element **12,** and simultaneously warm the water as it flows into the velocity transducer **14** via the passage **42,** and then through the tip **16** via the passage **64**. The handpiece **70** is preferably constructed from an inner cylindrical piece **82**, with an inside diameter forming the well **80** and around which the wire is wrapped to form the coil **74**, and an outer cylindrical piece **84** threaded to the inner cylindrical piece **82** at a proximal end and threaded to engage tail nut **86** at a distal end. The water tubing

76 and wires 72 are protected in a cable sheath 88 which runs to a conventional power/water supply unit (not shown).

As the water is ejected from the proximal end 60 of the tip 16, it serves as a transmission medium between the tip 16 and the surface of the tooth or tissue with which the tip 16 is being operated, and also serves to cool the tissue or tooth surface and flush away any debris or foreign material, as is known in the art.

When it is desired to use a different tip, the tip 16 is replaced with the tip of desired configuration and characteristics. When the magnetostrictive element 12 needs to be replaced, this can be done by removing the insert 10 from the handpiece and using wrenches with elongated elements to engage the respective transverse passages 28 and 40 to unthread the magnetostrictive element 12 from the velocity transducer 14. In this manner, the velocity transducer 14 can be used with a series of interchangeable tips 16, or with different magnetostrictive elements 12, for example, for use in different handpieces.

To use the trimodular insert of the present invention with a specific power supply, the dental practitioner maintains an inventory of a magnetostrictive element and a velocity transducer, perhaps with one or two replacement magnetostrictive elements and velocity transducers to use in the event of failure or while the others are being sterilized as in an autoclave, and a variety of tips. The dental practitioner can use a wide array of tips without having to purchase an entire insert for each type of tip. Moreover,

the dental practitioner can simply replace the tip if it becomes worn or breaks, rather than the entire insert.

The system can also be used with different power supplies. For example, if a dental practitioner has 25 kHz and 30 kHz ultrasonic dental generators, the tips from the practitioner's set can be used with both machines by changing the magnetostrictive element, and/or the velocity transducer if the handpieces of the two (or more) machines are not compatible. In general different types of velocity transducers are used to fit the handpieces of various ultrasonic generator manufacturers.

The magnetostrictive elements and tips can be releasably attached to the velocity transducer by rolled threaded connection as described above, but the present invention also contemplates that other connection means can be suitably employed, such as, for example, collets, twist-snaps, captive nuts or the like. The velocity transducer and tips can be configured for external water flow, as well as the internal water flow illustrated above.

The above description is only illustrative of embodiments of the invention. Various changes and modifications of these embodiments will occur to the skilled artisan in view of the preceding specification. It is intended that all such modifications and changes within the scope and spirit of the appended claims be embraced thereby.

CLAIMS

1. A three-part ultrasonic dental insert for use in a handpiece having an induction coil disposed about a well and operably connected to a power supply comprising:

a magnetostrictive element having a crown at one end, wherein the element is adapted to be received in the well and has a magnetostrictive frequency matching the coil and power supply;

a velocity transducer having proximal and distal ends, wherein the distal end is releasably attached to the crown of the magnetostrictive element;

a tip having a distal end releasably secured to the proximal end of the velocity transducer, wherein the velocity transducer and the tip are ultrasonically operable with the coil and magnetostrictive element.

2. The insert of claim 1 wherein the insert is threadedly engageable with a proximal end of the handpiece.

3. The insert of claim 1 comprising a continuous passage for water through the crown, velocity transducer and tip.

4. The insert of claim 1 wherein the crown has tapered external threads engageable by tapered internal threads formed in the distal end of the velocity transducer.

5. The insert of claim 4 wherein the tapered threads have rounded ends.

6. The insert of claim 1 wherein the distal end of the tip is threadably engaged with the proximal end of the velocity transducer.

7. The insert of claim 1 wherein a proximal end of the tip corresponds to a node of maximum vibration and the attachment of the crown to the velocity transducer corresponds to the antinode.

8. A three-part ultrasonic dental insert for use in a handpiece having an induction coil disposed about a well and operably connected to a power supply comprising:

a magnetostrictive coil;

a velocity transducer element releasably attachable to the magnetostrictive coil;

a set of interchangeable tips, each tip having a distal end releasably attachable to the proximal end of the velocity transducer, wherein the velocity transducer and the tips are ultrasonically operable with the coil and the magnetostrictive element.

9. The insert of claim 8 wherein a proximal end of each tip corresponds to a node of maximum vibration and the attachments of the velocity transducer to the magnetostrictive element and to each tip correspond to antinodes.

10. A three-part replacement system for repairing ultrasonic dental inserts for use in handpieces having an induction coil disposed about a well and operably connected to a power supply, comprising:

a set of magnetostrictive elements having a crown at one end, wherein the elements are receivable in the well of a handpiece and the set includes at least two elements having different magnetostrictive frequencies to match coils operable at different frequencies;

a set of velocity transducers having proximal and distal ends, wherein the distal ends are releasably attachable to the crowns of the magnetostrictive elements;

a set of interchangeable tips having distal ends releasably attachable to the proximal ends of the velocity transducers, wherein the velocity transducers and the tip sets include a plurality of transducers-tip combinations ultrasonically operable at the ultrasonic frequencies of the magnetostrictive elements.

11. The replacement system of claim 10, wherein the set of velocity transducers includes at least one velocity transducer matched for interchangeable operation at different ultrasonic frequencies with at least two different magnetostrictive elements.

12. The replacement system of claim 11 wherein the interchangeably operable velocity transducers are operable at the ultrasonic frequency pairs selected from the group consisting of about 18 kHz and about 18.8 kHz, and about 25 kHz and about 30 kHz.

13. The replacement system of claim 11 wherein the set of tips includes a plurality of tips operable with a plurality of velocity transducers for operation at different ultrasonic frequencies.

14. The replacement system of claim 10 wherein each insert is threadedly engageable with a proximal end of the handpiece.

15. The replacement system of claim 10 comprising a continuous passage for water through the crowns, velocity transducers and tips.

16. The replacement system of claim 10 wherein each crown has tapered external threads engageable by tapered internal threads formed in the distal ends of the velocity transducers.

17. The replacement system of claim 16 wherein the tapered threads have rounded ends.

18. The replacement system of claim 10 wherein the distal ends of the tips are threadably engageable with the proximal ends of the velocity transducers.

19. The replacement system of claim 10 wherein proximal ends of the tips correspond to a node of maximum vibration and the attachment of the crowns to the velocity transducers corresponds to the antinode.

20. The replacement system of claim 11 wherein proximal ends of the tips correspond to a node of maximum vibration and the attachment of the crowns to the velocity transducers corresponds to the antinode.

21. The replacement system of claim 13 wherein proximal ends of the tips correspond to a node of maximum vibration and the attachment of the crowns to the velocity transducers corresponds to the antinode.

22. A method for maintaining an ultrasonic dental tool comprising a handpiece having an induction coil disposed about a well and operably connected to a power supply and an insert having a magnetostrictive element disposable in the well, comprising:

using the three-part ultrasonic dental insert of claim 1 in the handpiece;

maintaining a replacement set of insert components comprising the magnetostrictive element, velocity transducer and tip;

upon failure of the insert used in the handpiece, disassembling the insert to remove the failed component(s) thereof and replace the failed component(s) with component(s) from the replacement set.

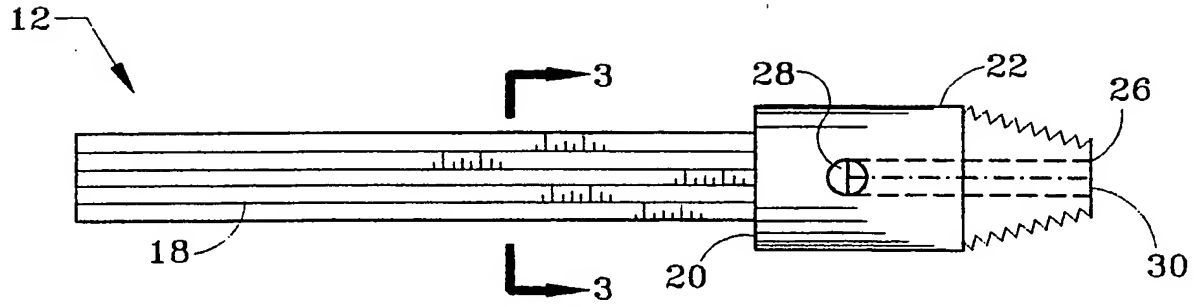

FIG.1

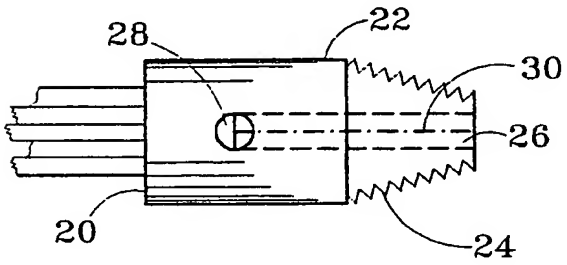

FIG.2

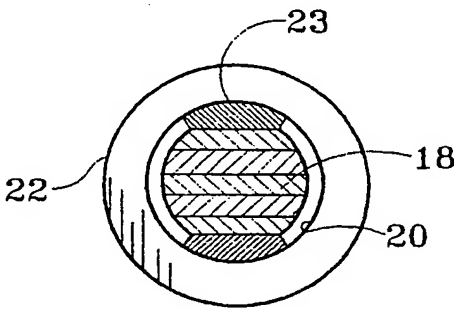

FIG.3

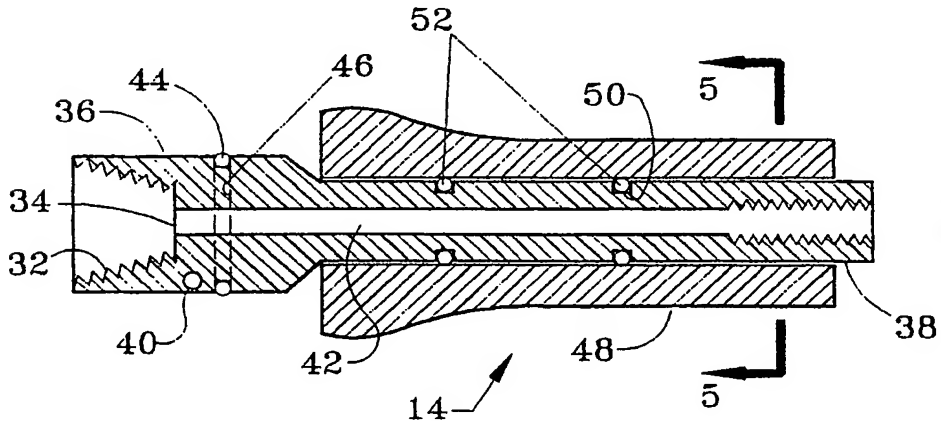

FIG.4

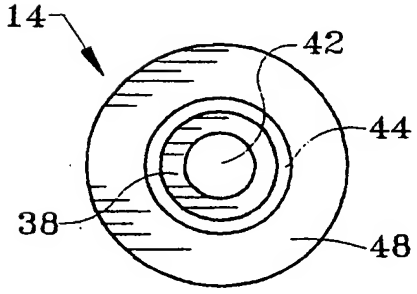

FIG.5

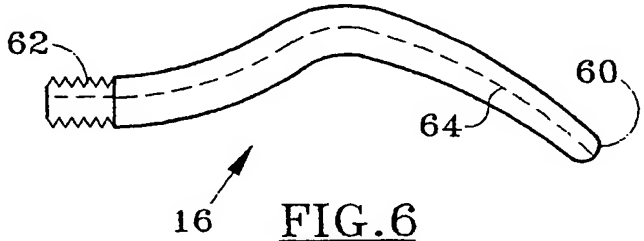

FIG.6

TRIMODULAR ULTRASONIC DENTAL DEVICE

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Applicant(s):	ULTRASONIC SERVICES INC (US); FEINE JAMES (US)
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Abstract

A three part ultrasonic dental insert (10), and replacement system (12, 14, 16) used in a handpiece (70) having an induction coil (74) disposed about a well (80), and operably connected to a power supply. The three parts include a magnetostriction element (12), a velocity transducer (14), and a tip (16). The magnetostriction element (12) has a crown (22) at one end which is releasably attached to a proximal end of the velocity transducer (14). The tip (16) is releasably attached to a proximal end of the velocity transducer (14). The insert (10) can comprise a set of interchangeable tips (16) wherein the velocity transducer (14), and the tips (16) are ultrasonically operable with the coil (74), and the magnetostriction element (12). The three part replacement system (12, 14, 16) comprises a set of magnetostriction coils (12), and a set of the velocity transducer elements (14), as well as the interchangeable tips (16). The velocity transducer (14), and tip (16) sets include a plurality of transducer tip combinations (14, 16) operable at the ultrasonic frequencies of the magnetostriction elements (12).